FIRELINE RECLAMATION

on

TWO FIRE SITES

in

INTERIOR ALASKA

by Larry Knapman

U. S. DEPARTMENT OF THE INTERIOR

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Alaska

contents

the author

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FIRELINE RECLAMATION

On Two Fire Sites in Interior Alaska

by Larry Knapman

In Interior Alaska, firelines are often constructed to help control and contain wildfires. In the early 1960s and early 1970s, the firelines were built, as in the western States, by tractors with bulldozer blades that scraped off the organic mat, knocked down trees, and pushed all material to one side of the line. The tractors worked back and forth across the fireline until mineral soil was exposed. Usually, most of the developed soil was removed with the organic mat.

Firelines often were built on the easiest route between two points where lines could be constructed most rapidly. Slope, aspect, and soil condition on the route were considered primarily in relation to fire suppression effectiveness rather than permafrost, potential erosion, or reclamation problems and solutions.

The term "permafrost" describes a condition in which ground temperature remains below freezing for 2 or more years. Above the permanently frozen soil is an "active layer" which thaws and freezes each year. The active layer found in Interior Alaska may be from 2 to 10 feet thick.

The two characteristics of soils in permafrost areas which cause problems when these soils are disturbed are moisture content and soil particle size. Permafrost containing a large amount of water is referred to as "ice-rich," and in extreme cases the ice may be present in lenses or wedges several feet thick. When ice-rich soils thaw, abundant free water is available and can cause runoff, erosion, and sedimentation, even in the absence of rainfall.

Whether or not erosion and sedimentation will occur following the construction of firelines depends upon the soil particle size and the shape of the surface. Fine-grained soils that are also

ice-rich are termed "thaw-unstable soils" and are extremely unstable and easily erodible when the protective cover of organic matter is removed. On the other hand, coarse-grained gravelly soils are much more stable even if they are ice rich. Soils of any grain size that contain little moisture are generally thaw stable.

Firelines may, therefore, both help contain and control fires and also cause erosion problems. Figures 1, 2, and 3 show some examples of erosion following fireline construction.

The Wickersham Dome fire occurred in 1971 and the Alps* fire in 1975. Attempts made to counteract harmful effects of fireline construction were among the earliest such attempts in Interior Alaska. Specific efforts were made to control erosion, prevent stream siltation, and encourage revegetation.

The author recorded observations and took pictures in the course of other work, and not as part of a scientific investigation. There was no experimental design or control plots to test either methods or materials for erosion control, but merely observation of the effects of the practices used in constructing and reclaiming firelines. Because of the informal methods used in this study and the small amount of data, we cannot reach firm conclusions nor offer solid recommendations for fireline reclamation, but we do believe the 10 years of experience here should be shared with other land managers in Alaska.

The observations suggest that fireline erosion in Interior Alaska can be largely prevented in two ways:

1. By providing proper water control, such as waterbars and water diversion cuts, and

2. By replacing the vegetation or organic mat and associated developed soils that were removed during construction. The materials can be replaced either by crews with shovels and other tools or spread with a bulldozer.

Natural revegetation occurs rapidly (within 3 years) on damp and poorly drained sites. Extremely well-drained sites are difficult to revegetate.

The so-called organic material or layer frequently includes most of the developed soil on the site. Replacing it appears to be very important to revegetation. The material is a source of roots, seeds, and rhizomes. The organic material also acts as a mulch, preventing sheet and rill erosion and holding moisture.

**The Alps fire began at a U. S. Air Force site of the Alaska Long Period Array (ALPA) type. In the confusion of fighting the fire, workers called it the Alps fire. That name has persisted in records and discussions about the fire.*

FIGURE 1. Ice in the ice-rich silt melted after the organic mat was removed during fireline construction. Photo was taken a few days after organic mat removal. Wickersham Dome fire, June 1971.

FIGURE 2. Heavy equipment tracks formed channels that collected runoff water from melting ground ice and precipitation in this fireline section of the Wickersham Dome fire. The channeling encourages head cutting, a form of continuing erosion.

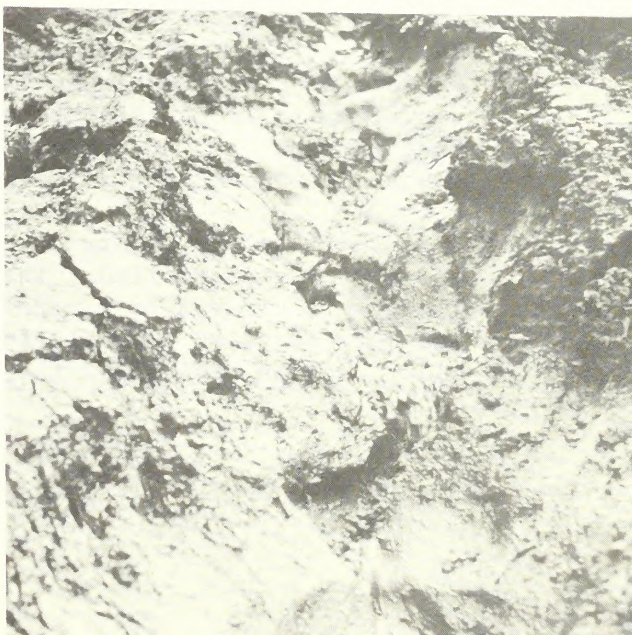


FIGURE 3. This fireline section is on a north-facing slope. The organic mat was removed 10 days earlier during fireline construction for the Wickersham Dome fire. Ice in the permafrost melted when the insulating organic material was stripped away. The melting was hastened by light rain that fell for several hours.

Description of Fire Sites

The Wickersham Dome fire in 1971 and the Alps fire in 1975 both occurred in the Washington Creek and the Wickersham Creek drainages, about 25 miles (40 km) north of Fairbanks, Alaska. See Figure 4 for the locations of the fires.

The land is hilly and is divided by streams that run mostly southwest or northeast. Elevations vary from 740 feet (226 m) at the southwest end of the Wickersham Dome fire to 2,245 feet (684 m) on the north edge of the Alps fire. Some slopes are steeper than 100 percent.

The taiga or boreal forest through which both fires burned is composed primarily of black spruce/feathermoss and black spruce/sphagnum vegetation cover types. A few stands of birch and aspen are interspersed among the black spruce. Willow and dwarf birch grow along creeks. Tussock meadows occur in some poorly drained areas.

Soils are formed in a mantle of silty materials over mica schist bedrock. The silt mantle is made up of a thin loess deposit over residuum from weathered schist. The depth varies from a few inches on ridgetops and steep slopes to several feet on foot slopes and valley bottoms. Ice-rich permafrost occurs in most of the soils of the north-facing slopes, footslopes, and valley bottoms but is usually absent in soils on ridgetops and upper south-facing slopes.

The area has a cold continental climate. Winter temperatures fall to -40°F (-40°C) and summer temperatures climb to the high 80s (°F). The mean annual temperature is probably about 25°F (-4°C). The mean annual precipitation is estimated to be between 12 and 14 inches (30 and 36 cm).

The Wickersham Dome Fire--1971

The Fire

The Wickersham Dome fire began on June 25, 1971, and covered approximately 16,000 acres (6,478 ha). Because of the fire's proximity to private property, BLM manned it heavily with 710 firefighters. The firefighters used 26 crawler-type tractors to construct firelines.

The fireline construction was not strictly controlled. The firelines were cleared to mineral soil and were 40 to 60 feet (12 to 18 m) wide. By the time the fire was finally contained, approximately 70 miles (113 km) of fireline had been constructed. Exposed ground ice began melting. By July 4, the water in Washington Creek, which had been clear 2 days earlier, was carrying a heavy load of silt from the eroding firelines.

Reclamation Measures

WATER DIVERSION STRUCTURES--The BLM Fairbanks District personnel decided that the firelines had to be treated immediately to reduce erosion and the resulting

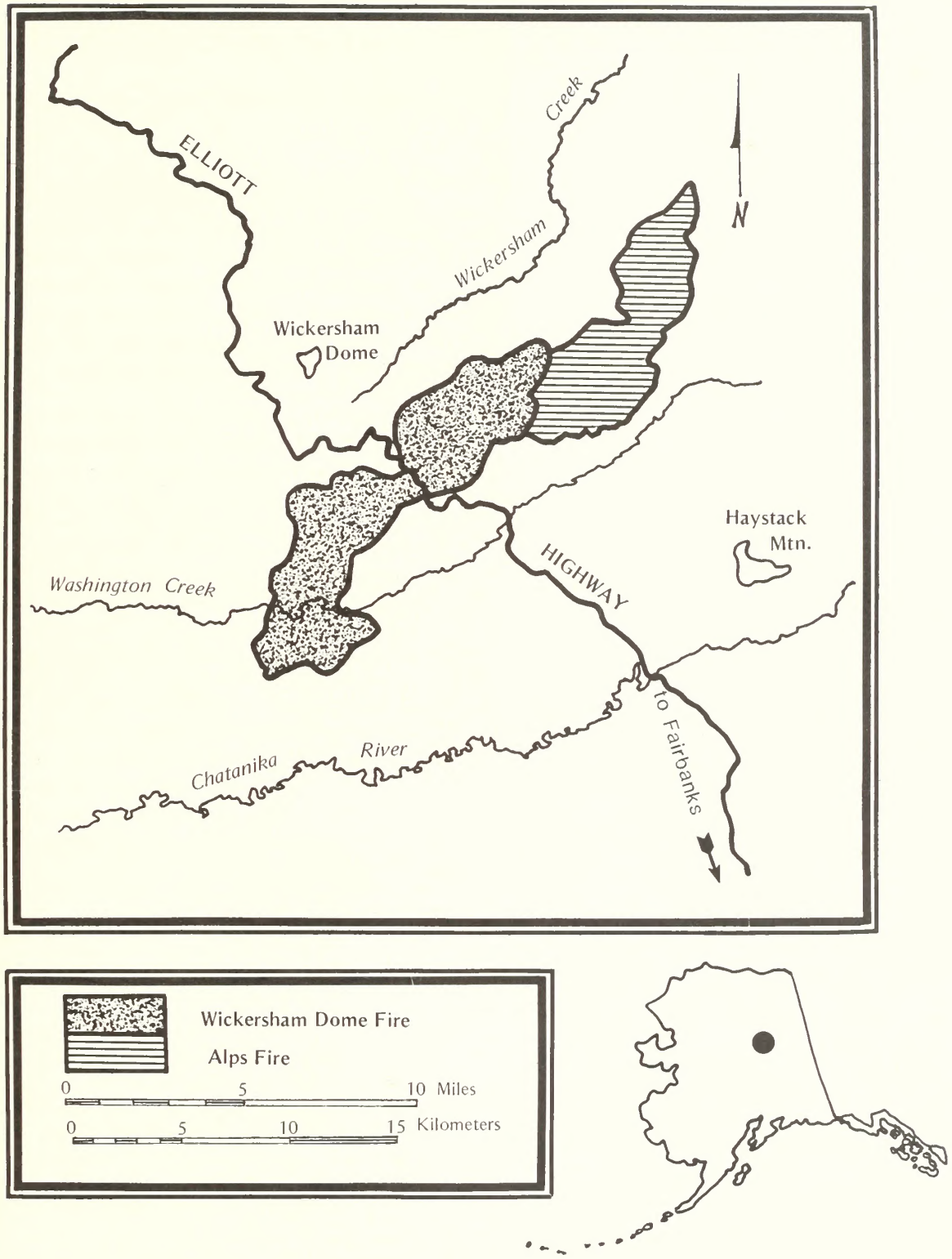


FIGURE 4. Locations of the Wickersham Dome and Alps fires, 1971 and 1975, respectively. The area is about 25 miles (40 km) north of Fairbanks, Alaska.

silt pollution of streams. For initial treatment, they constructed water diversion structures across the firelines, using tractors.

The type of diversion and spacing between diversions were determined by the type of earth materials, slope, and aspect at each site. In moderately drained areas where surface materials contained large amounts of fragmented schist parent materials, earthen waterbars were angled to drain runoff onto the unburned side of the lines. In some areas, water diversion cuts 1 to 2 feet (30 to 60 cm) deep were made across the firelines with a corner of the bulldozer blade.

On sites with fine-grained, ice-rich materials, waterbars were constructed of the vegetation and earth materials removed during fireline construction. The size of the waterbars depended on how much material was available to build them. Heights ranged from 3 to 8 feet (1 to 2.5 m).

When possible, tractor operators sealed the uphill sides of the bars by pushing earth material from the firelines against them. No waterbars were placed on flat or contoured sidehill sections of lines, except near drainage crossings.

SEEDING AND FERTILIZING--In April 1972, 250 acres (101 ha) of fireline were seeded and fertilized from a helicopter. Seed mix was applied at 40 pounds (18 kg) per acre and fertilizer at 300 pounds (136 kg) per acre. Mixtures were as follows:

Seed

Manchar smooth brome . .	37.5%
Creeping red fescue. . .	37.5%
Rodney oats.	25.0%

Fertilizer

N10-P20-K20 (in pellet form)

Observations on Reclamation Success

In August 1972, BLM personnel established photo points and took photographs to monitor revegetation on the firelines. They rephotographed the sites from these points in 1975 and 1978.

Where waterbars were properly spaced and constructed, erosion was slight and revegetation was rapid. On sites with adequate moisture and some soil development, a plant cover of 20 to 40 percent was estimated from the 1972 photographs.

By 1975 these sites were 80 to 95 percent covered by litter and living plants. Seeded species were difficult to find. Native species dominated the sites; only one site had a dominant species that was exotic. Seedlings of woody stemmed plants, such as willow, alder, birch, aspen, and spruce, were common.

In 1978 shrubby cover had developed on well-drained south- and west-facing slopes. Stems of willow and alder were up to 8 feet (2.5 m) tall. On east- and north-facing slopes, plant cover did not develop as rapidly, but basically the same trend was observed.

Ridgetops and the upper third of south-facing slopes have thin soils and tend to be drouthy. Revegetation with seed and fertilizer was usually successful there, but the amount of plant cover tended to diminish after 3 or 4 years when the fertilizer was used up.

FIGURES 5A, 5B, and 5C show a fireline section on an east-facing slope. The site is wet and the original cover type was black spruce. Photos were taken from the same point 1, 4, and 7 years after the Wickersham Dome fire.

FIGURE 5A--August 1972--13 months after the fireline was built and 4 months after it was seeded and fertilized. No seeded species are evident, but very little erosion is taking place.

FIGURE 5B--September 1975. Ground cover is mostly mosses and horsetail. A moderate stand of bluejoint and willow is developing. Spruce seedlings are common.

FIGURE 5C--September 1978. Mosses and horsetail are still the major components of the ground cover. Black spruce, willow, and bluejoint are increasing in density.

FIGURES 6A, 6B, and 6C show a fireline section on a west-facing slope. The site is well drained and has a spruce, birch, aspen cover type. Photos were taken from the same point 1, 4, and 7 years after the Wickersham Dome fire.

FIGURE 6A--August 1972. Grass has grown in wet areas, with a higher percentage of forbs in the dryer areas. There is little evidence of standing or running water, and only slight erosion has occurred.

FIGURE 6B--September 1975. Ground cover is 90 to 95 percent and blue-joint is the dominant species. Seeded species are rare. No significant erosion has occurred.

FIGURE 6C--September 1978. The fire-line cover has become a shrub type, with willows, alder, rose, and raspberry the most obvious species. Paper birch, aspen, and white spruce also may be seen.

FIGURES 7A, 7B, and 7C show a fireline section on a well-drained, south-facing slope, with a spruce-aspen cover type. Photos were taken from the same point 1, 4, and 7 years after the Wickersham Dome fire.

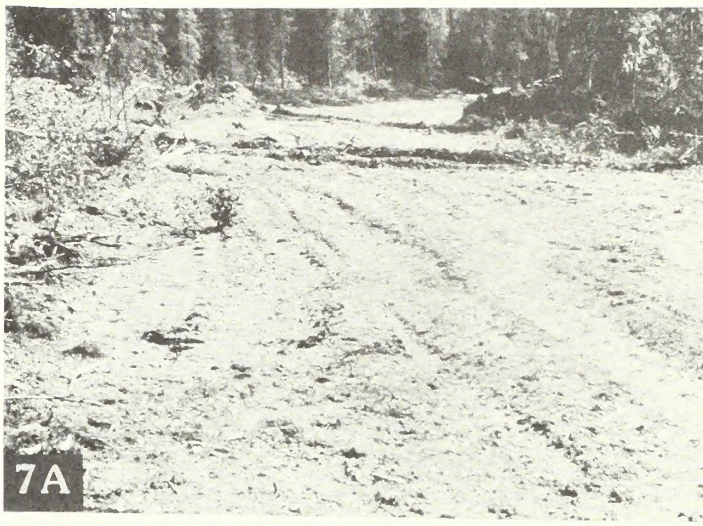
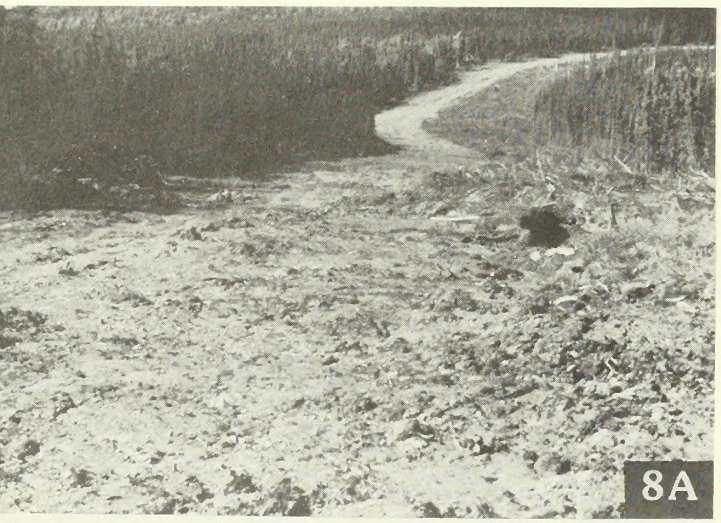


FIGURE 7A--August 1972. Seeded species have reached a height of about one inch (2.5 cm). Only slight erosion is occurring.

FIGURE 7B--September 1975. Seeded brome is the dominant species, but the percentage of ground cover is low.

FIGURE 7C--September 1978. Ground cover still is only 50 to 60 percent. Very little bromegrass has survived, and forbs are increasing. Willows, aspen, and alder have increased to form a shrub cover type.



FIGURES 8A, 8B, and 8C show a fireline section on a well-drained, north-facing site in a black spruce cover type. Photos were taken from the same point 1, 4, and 7 years after the Wickersham Dome fire.

FIGURE 8A--August 1972. There was little response from the seeded species. Sheet and rill erosion are apparent but not serious. Some gullying is occurring on the south-facing slope in the background.

FIGURE 8B--September 1975. Ground cover is of native grasses, forbs, and mosses, with occasional willows. It has improved to about 70 percent. Sheet and rill erosion are slight.

FIGURE 8C--September 1978. Willow, alder, and spruce are now more noticeable than they were in 1975, but have not progressed as much as on other sites, probably because north slopes generally are colder than slopes with other exposures.

The Alps Fire--1975

The Fire

The Alps fire started July 10, 1975, approximately 2 miles (3 km) northeast of the northeastern limit of the Wickersham Dome fire of 1971. Winds were from the southwest. Smoke jumpers attacked the fire, and retardant was dropped from airplanes. At approximately 1600 hours, the wind shifted 180 degrees, and the fire began moving into the Washington Creek Ecology Fire Research Area.* The Elliott Highway and private property were 6 to 7 miles (10 to 11 km) downwind. Two to three miles (3 to 5 km) beyond the highway, the trans-Alaska oil pipeline was under construction. To protect these areas, a decision was made to use crawler tractors for building firelines to contain the fire.

The following criteria were established for fireline construction:

1. Tractors would strip one blade width to mineral soil and walk down five to ten blade widths between the mineral strip and the fire. (Walk down is the practice of using a tractor with the bulldozer blade positioned above ground level to push trees over without tearing into the organic mat.)

2. Mineral strip blading would stop 100 to 150 feet (30 to 45 m) from creek crossings. Walk down could continue to waters' edges.

3. Firelines were to be located on the contour or on ridgetops when possible.

4. All tractors were to be accompanied by resource specialists, functioning as tractor bosses.

Not all sections of fireline were constructed according to these criteria because of communication and equipment problems. Eight miles (13 km) of new line were constructed and three lines from the Wickersham Dome fire were reused.

On the afternoon of July 12, a severe storm passed over the fire. A recording gauge at the meteorology station established for a nearby research project measured 1.75 inches (4.48 cm) of rainfall in 3 hours. The rain significantly reduced the intensity of the fire, and caused gullying in several sections of fireline. It also added to soil instability where lingering seasonal frost and permafrost had melted in several small sections of line.

Reclamation Measures

As soon as a section of the fireline was considered "safe," reclamation measures were begun on it. A section was declared safe when it had no active fire and only occasional smokes. Crews were stationed along the line to mop up smokes as they appeared.

WATER DIVERSION STRUCTURES AND ORGANIC MAT REPLACEMENT--Reclamation was intended to be a combination of controlling water and replacing the organic mat on the mineral strip. Seeding was planned only where

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**At the time of the fire, the land was administered by the BLM and used jointly for fire research by the BLM, the USDA Forest Service Institute of Northern Forestry, and the University of Alaska.*

necessary, on a site-by-site basis.

On most lines, tractors with bulldozer blades were used to replace the organic mat. Operators backed the tractors into the forest and pushed the berms of vegetation mat forward onto the mineral strip. In well-drained areas, they then could work the tractors on the line, spreading the material from the berms.

In poorly drained areas with deep mud, the berms were pushed onto the lines as waterbars, spaced 20 to 50 feet (6 to 15 m) apart. Operators attempted to seal the bars to the vegetation mat on both sides of the mineral strip between the waterbars. This was done, as much as possible, without moving the tractors in the mud. The tractors worked on top of the bars, thereby compressing the material and squashing it into the mud of the mineral strip to reduce washouts.

One line segment was burned on both sides. The line is on a ridge-top and runs down a steep south-facing slope. The berms of vegetation mat were consumed by the fire, leaving practically no material to return to the mineral strip for reclamation. Treatment for this segment consisted solely of building devices for water control--earthen waterbars and water diversion cuts.

Considerable rill and sheet erosion occurred between water control structures on steep portions of some lines during the first year after the fire. The water control structures prevented gullying except at a few places where the water flowed around the waterbars.

SEEDING--One segment of very wet line was seeded. A mixture of annual ryegrass, creeping red fescue, meadow foxtail, and Manchar smooth brome was spread by hand at rates of from 40 to 60 pounds (18 to 27 kg) per acre. No fertilizer was used.

Observations on Reclamation Success

In Interior Alaska, organic mat removal by heavy equipment during fireline construction usually also removes most or all of the developed soil. On the Alps firelines, replacing the organic mat by hand or machine partially replaced that soil and was an effective method of controlling erosion. The replaced organic mat not only retarded runoff and reduced erosion, but also served as a source of available nutrients, dormant seeds, rootstocks, and rhizomes. It also modified microclimates (see Figure 11), making them more suitable for seed germination and seedling development.

Firelines constructed on wet sites tended to erode and be unstable because they have fine-grained earth materials that are unstable when thawed and exposed. Once they were stabilized, however, wet sites revegetated more rapidly than those on well-drained ridgetops.

At the only site that was seeded, plant cover of the exotic species developed more rapidly than did cover on sites allowed to revegetate naturally. The seeding seemed to retard the establishment of native plants, however. This effect still was evident at that site 5 years after the fire.

Organic mat replacement immediately softened the visual impacts of the fireline (see

Figure 11B). It also discouraged or excluded offroad vehicle (ORV) traffic on the fireline. ORV traffic can cause significant damage on firelines that have been seeded and provided with waterbars.

The photo series on the following pages, Figures 9 through 12, are of fireline sections on the Alps fire. The site in the series labeled Figure 9 is the only one shown that was seeded. The plants on sites shown in Figures 10 through 12 recolonized naturally, although water control was provided and the organic material replaced on the mineral strips.

FIGURES 9A, 9B, 9C, and 9D show a fireline section on the Alps fire. The line was constructed on poorly drained, fine-grained materials, on a very gentle east-facing slope with a black spruce cover type. This fireline was too wet to permit spreading berm materials by tractor. Therefore, the berms were pushed onto the mineral strip as waterbars. Care was taken to ensure that the waterbars contacted the vegetation mat well on both sides of the mineral strip. This segment of the line was seeded by hand but not fertilized.

FIGURE 9A--July 1975. The fireline before treatment that included seeding.

FIGURE 9B--August 1976. The fireline one year after treatment. We observed no significant erosion. Ground cover was mostly of seeded species.

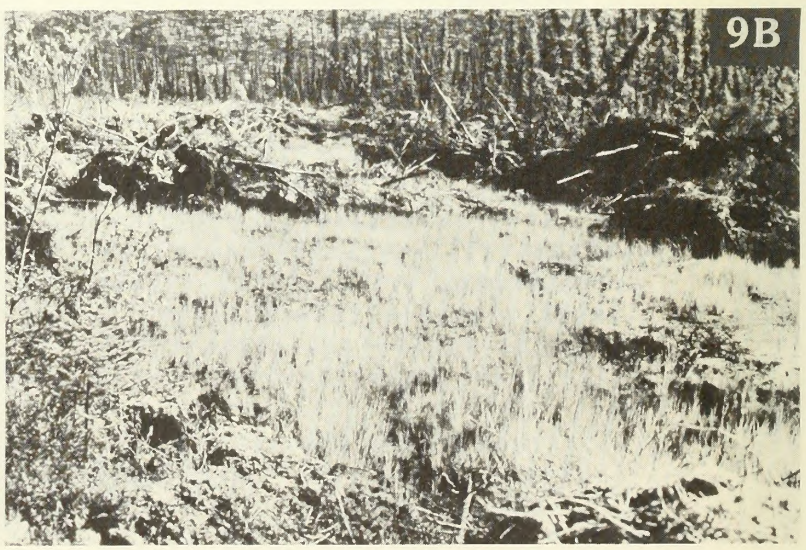

FIGURE 9C--September 1977. Seeded species continue to dominate.

FIGURE 9D--September 1978. Some additional growth of native species is evident.

FIGURE 10A--July 1975. The fireline before reclamation began.

FIGURE 10B--July 1975. A section just after the fire crews had replaced the organic material that had been removed during fireline construction.

FIGURE 10C--May 1976, just as spring growth was starting.

FIGURE 10D--September 1977. Grass and horsetail are the most noticeable plant species.

FIGURE 10E--September 1978. Three years after the site was disturbed, revegetation is progressing satisfactorily.

FIGURES 10A, 10B, 10C, 10D, and 10E. The fireline section shown in this series of photos on the Alps fire site is on ice-rich, finely shattered schist materials. It is on a southwest-facing slope, with a black spruce cover type. When the organic mat was removed, the ground ice thawed rapidly, causing solifluction (or slumping of soils) in several steep places. A rainstorm struck 2 days after the fire started. Precipitation from the storm cut gullies up to 20 inches (51 cm) deep. Several waterbars were constructed shortly after the storm was over. Two days later, when reclamation efforts began, the materials were too soft and unstable for tractors to be used on the line without doing more damage than had already been done. Fire crews stationed along this fireline segment to watch for smokes replaced the organic material by hand. Neither seed nor fertilizer was used.

After the fireline was treated, all revegetation was natural, and erosion was practically nonexistent. Although solifluction stopped shortly after the organic mat was replaced, it is questionable that replacing the mat stopped the solifluction.

The most common species revegetating the area are bluejoint, Labrador tea, blueberry, horsetail, black spruce, and mosses.

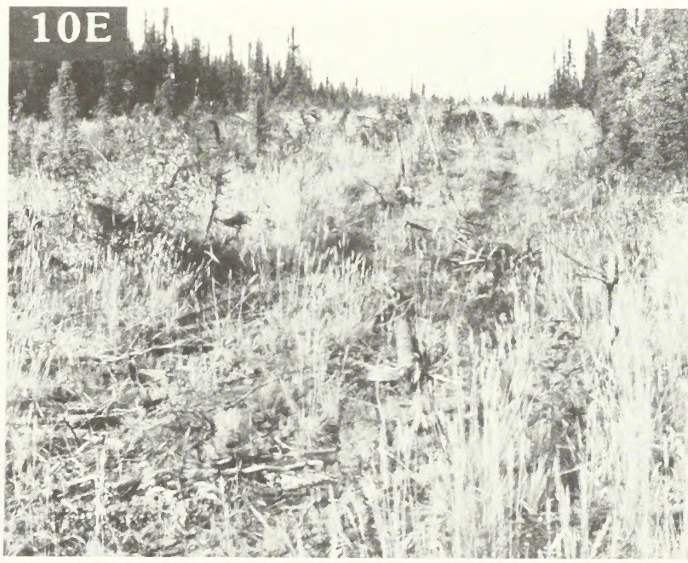

FIGURE 11A--July 1975. The fireline before the berms were pushed back onto the mineral strip.

FIGURE 11B--August 1975. This aerial view shows the fireline after berms had been spread over the mineral strip. Covering the mineral strip with organic material not only retards erosion, but also makes the fireline less visible by reducing the "straight-line effect" or the stark contrast of a line through natural growth.

FIGURES 11A, 11B, 11C, 11D, and 11E. This fireline section on the Alps fire site is well drained and nearly level. It has medium-grained soil materials, with a black spruce cover type. Generally, this section of line was dry enough to permit berm materials to be spread with a tractor after they were pushed onto the mineral strip. Neither seed nor fertilizer was applied.

FIGURE 11C--August 1976. Because of the drouthy conditions of the site, revegetation is occurring mainly in soil clumps and patches that are protected from the wind.

FIGURE 11D--September 1977. The fireline section is being re-colonized by grasses, mosses, willows, and black spruce. Moss invasion is greatest on bare soil that was protected from being wind dried.

FIGURE 11E--September 1978. Three years after the fire, most protected bare-soil areas in the fireline section are covered with some kind of vegetation. Erosion is not a problem.

FIGURE 12A--July 1975. The fireline before reclamation. The gully on the right is a result of runoff from the storm that stopped the fire.

FIGURE 12B--July 1975. This photo was taken while the fireline was being treated. A water-diversion cut is in the foreground.

FIGURES 12A, 12B, 12C, 12D, and 12E show a fireline section on the Alps fire site on moderately well-drained soils in shattered mica schist. It is on a south-facing slope, with a black spruce cover type. Because big trees were among the organic materials removed from the line when it was constructed, it was almost impossible to spread the material back on the line. Instead, tractors were used to push it out to form waterbars. The waterbars were augmented with water-diversion cuts.

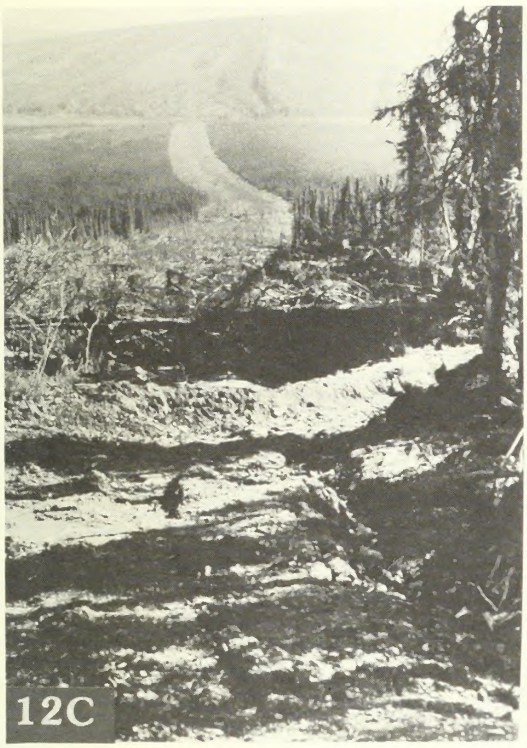

FIGURE 12C--August 1976. Bluejoint and mosses are the major colonizers.

FIGURE 12D--September 1977. Ground cover of grass and mosses has increased since Photo 12C was taken. Erosion has practically ceased.

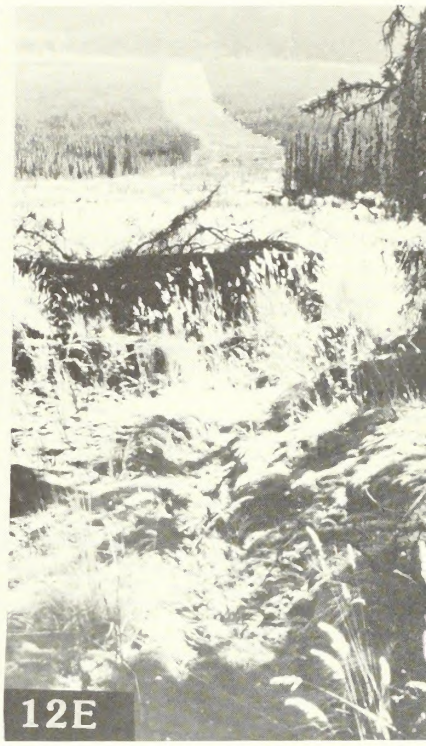

FIGURE 12E--September 1979. Bare ground is almost completely covered, and bluejoint has increased in vigor and density.

Plant Species

Native Species

Horsetail	*Equisetum* spp.
Bluejoint	*Calamagrostis* spp.
Willow	*Salix* spp.
Black spruce	*Picea mariana*
White spruce	*Picea glauca*
Alder	*Alnus crispus*
Rose	*Rosa acicularis*
Raspberry	*Rubus idaeus*
Paper birch	*Betula papyrifera* var. *humilis*
Aspen	*Populus tremuloides*
Labrador tea	*Ledum groenlandicum*
Blueberry	*Vaccinium uliginosum*

Exotic Species used to reseed some firelines

Annual ryegrass	*Lolium multiflora*
Nugget Kentucky bluegrass	*Poa pratensis*
Red fescue	*Festuca rubra*
Manchar smooth brome	*Bromus inermis*
Meadow foxtail	*Alopecurus pratensis*

BLM-Alaska Technical Publications

In 1977 we began publication of reports to make available to appropriate audiences the results of BLM-sponsored studies, symposia, and administrative practices that could be applied in public land management.

Most of the reports published to date have been intended to facilitate the application of research and study results and to communicate with the scientific community. Our purpose has been to improve multiple-use management of the public lands.

There is also a wealth of resource management information derived from management experience and observation, rather than scientific studies. We intend to share this information through a series of Resource Management Notes. This publication is the first of those Notes.

Several of our earlier reports have dealt with fire in Alaska. They are as follows:

Racine, C. H. *The 1977 tundra fires in the Seward Peninsula, Alaska: effects and initial revegetation*. BLM-Alaska Technical Report 4. 51 pp. 1979. (NTIS Accession No. PB-116015)

USDI, Bureau of Land Management, Alaska. *Fire management in the northern environment (Partial proceedings of the symposium, October 1976)*. BLM-Alaska Proceedings 79/01. 102 pp. 1979. (NTIS Accession No. PB-80-123672)

Viereck, L. A., and L. A. Schandelmeier. *Effects of fire in Alaska and adjacent Canada--a literature review*. BLM-Alaska Technical Report 6. 124 pp. 1980. (NTIS Accession No. PB81-115438)

Copies of Technical Report 6 are available from the Alaska State Office, Bureau of Land Management, 701 C Street, Box 13, Anchorage, Alaska 99513. The other two publications are out of print and no longer available from BLM. Copies may be purchased in either paper or microfiche from the National Technical Information Service (NTIS), Springfield, Virginia 22151.